Practical Integrated Resource Planning with Demand-Side Planning and Management: A Policy Guide

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Introduction

Until the early 1970s, utility planning involved forecasting the utility's long-term load and energy demand and, given that forecast, determining the proper set of supply-side resources needed to satisfy that demand. Electric loads were growing predictably and steadily, and utilities responded with new generation and transmission capital investments, completed in a timely manner as economically as possible. Load was increasing, the real cost of new plants brought on line was decreasing, and the result was decreasing or stable average electricity prices.

From the mid-1970s throughout the 1980s, many changes occurred in electricity markets. Changes like longer construction times, high interest rates, increased construction costs, and greater volatility of supply costs and fuel, increased the risk of depending solely on supply-side alternatives and strategies. These changes significantly altered the way utilities needed to plan.

On the demand side during this period, decreases in load growth, higher energy prices, the increasing importance of conservation and load management, and the initial emergence of wholesale and retail competition dramatically changed the electricity markets.

Utilities responded to these supply and demand changes by incorporating cost-effective demand-side management (DSM) programs and activities as viable alternatives to new supply-side resources. With this incorporation integrated resource planning was "born."

Throughout the 1990s, other major changes occurred that diminished the significance of and the reliance on DSM in the planning process. By the mid-1990s, the installed cost of new peaking generation had plummeted from the $500 - $600 per kW levels of the mid-to-late 1980s to $250 per kW by 1995. Naturally, as supply-side resources cheapened, many DSM activities became dearer, less cost-effective and less competitive.

During this same period, wholesale electricity markets and many retail markets were exposed to more competition (or, at least, the threat of it). Planners throughout the industry became consumed with figuring out how to economically dispatch power from a multitude of suppliers over perhaps several privately and publicly owned transmission networks to consumers served at retail by entities having no or diminished obligation to do so. This "commoditization" of electricity service once again led planners to take electricity demand as something exogenously determined and entirely outside of their influence. Demand-side planning, especially for energy efficiency and conservation programs, all but disappeared from the utility landscape.

Today, there is wide agreement regarding the central institutional changes needed to accommodate the structural changes in the electricity marketplace. The cost of supply-side alternatives is once more high enough to make many DSM activities and programs cost-effective and viable options to more generation and transmission capacity. Public concern for the environment and for a reliable and stable electricity supply network with low likelihood of brownouts and blackouts has never been higher — thus making people more willing than ever to participate in such programs. These realities make a discussion of practical integrated resource planning — DSM principles and processes — timely and relevant.

Integrated Resource Planning (IRP) Defined

Electric utilities that practice IRP modify their supply-side planning process by integrating programs and activities intended to influence the amount and timing of consumers' electricity purchases.

Integrated resource planning

- IRP is the process of meeting customers' needs for electrical energy.
- IRP considers a broad range of supply-side and DSM options in a balanced manner.
- The objective is to secure the lowest long-term electricity cost consistent with the quantity and quality of electric service desired by consumers.

Integrated resource planning encompasses traditional generation and transmission capacity planning, but it is broader. IRP undertakes to meld the consideration and implementation of demand-side and supply-side options for assuring adequate capacity to meet increases in demand. The result of IRP is a plan that most economically maximizes efficiency and customer satisfaction.

Demand-Side and Supply-Side Options

Demand-Side Options	Supply-Side Options
• Consumer Energy Efficiency such as energy efficient construction programs, energy efficient appliances, duct repair, and geothermal heat pumps	• Conventional Power Plants such as fossil fuel, life extensions of existing plants, and hydro/pumped storage
• Utility Energy Conservation such as demand response programs	• Non-Utility Owned Generation such as cogeneration, independent power producers, and distributed generation
• Rates such as time-of-use and interruptible	• Purchases such as requirement transactions, coordination transactions, and competitive bidding
• Renewables such as solar heating and cooling, photovoltaics, passive solar design, and daylighting	• Renewables such as biomass, geothermal, solar photovoltaic and thermal-electric, and wind

Adapted from the U.S. Office of Energy Efficiency and Renewable Energy's *Integrated Resource Planning*.

Supply options include power plant and transmission construction, fuel supply, and wholesale power purchases. These supply options are engaged to reliably provide the kilowatt-hours of electricity needed by consumers at the lowest reasonable cost.

Demand-side management refers to programs and activities designed to affect customer usage of electricity. This, in turn, affects:

- The amount of electricity that must be produced and delivered
- Customers' perceived value of electric service
- The cost of providing it

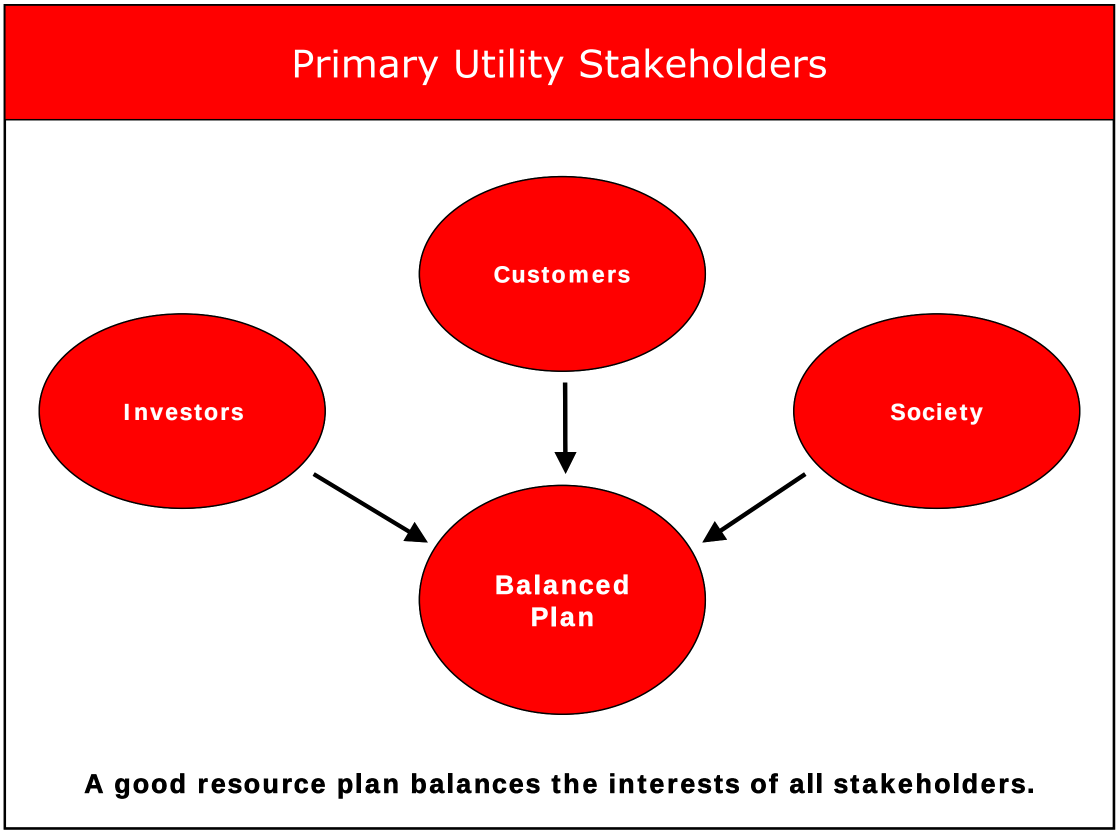
Demand-side options include conservation, customer-owned generation, new and expanded uses of electricity, strategic marketing initiatives, as well as traditional and price-responsive load management. When these are integrated into a resource plan, they may change system utilization, alter the need for or timing of additional generation or transmission capacity, change a system's dependence on a critical fuel type, or change the cost of electric service.

Demand-side and supply-side planning seek to improve the well-being of utility customers by improving the quality or value of service and by reducing the cost of service. These objectives apply whether a program is called "conservation," "load management," "promotional," "customer assistance," or "community development." They apply whether the means is providing new generation or transmission capacity through construction or purchase, spurring the availability and awareness of technology and applications through research and development, or by improving load factor through programs designed to encourage peak-shaving or valley-filling. Integrated resource planning looks beyond the perceived boundaries of particular programmatic labels. In a very real sense, integrated resource planning is market planning.

IRP Benefits and Uncertainties

Integrated resource planning is complex. A good resource plan must have three important characteristics.

- It must provide benefits to utilities' primary stakeholders, i.e., customers, investors, and society.
- It must be able to make the trade-offs required between the conflicting interests of these stakeholders.
- It must anticipate the future in light of the many types of uncertainties utilities face today.



The three groups affected by IRPs are the electricity customers; the utility's investors, members, or the voting constituency; and society. At times, the interests of one group, or even a subset of a group, may conflict with the interests of the larger group or with those of other stakeholders. "Least cost" for customers means a resource plan that minimizes the cost for their desired amount and quality of electric service. Investor interests are served when resource plans promote the utility's long-term financial health. Societal interests are served both by adequate and reliable power supply and delivery and by resource plans that are environmentally sensitive and promote economic growth. A successful integrated resource plan balances conflicting interests and determines acceptable trade-offs between cost reduction, risk, and the service preferences of the utility's stakeholders.

A benefit of integrated resource planning is that it helps manage stakeholder risks. The explicit consideration of a portfolio of both demand-side and supply-side resources mitigates the uncertainties of serving a diverse and changing electricity market. Considering a variety of options also permits customers to achieve enhanced value from their electric service while allowing utilities to better compete in the energy marketplace.

IRP Uncertainties	
• Load Growth	• Environmental Compliance
• New Construction Lead Times	• Fuel Price and Supply
• Regulatory Climate	• Capital Availability and Cost
• Competition	• Customer Adoption of New Technology
• Availability and Reliability of Purchased Power	• Construction Costs
• Adequacy of Transmission Network	• Economic Conditions
• Customer Acceptance and Participation in DSM	• Energy Policy Decisions

The list of uncertainties that must be taken into account when developing an IRP is a long one. Future economic conditions are difficult to forecast; customers' responses to prices and their willingness to participate in DSM are also difficult to anticipate; new technologies may not develop as projected; and purchased power sources may not be available or able to meet delivery requirements.

The potential impacts of these and other uncertainties are reduced when the resource planning process itself is fluid and when the resulting resource plans are flexible and diversified. An IRP is not a one-time effort; instead, as external events unfold and change, the plan should be modified accordingly.

Practical Integrated Resource Planning

Schematic

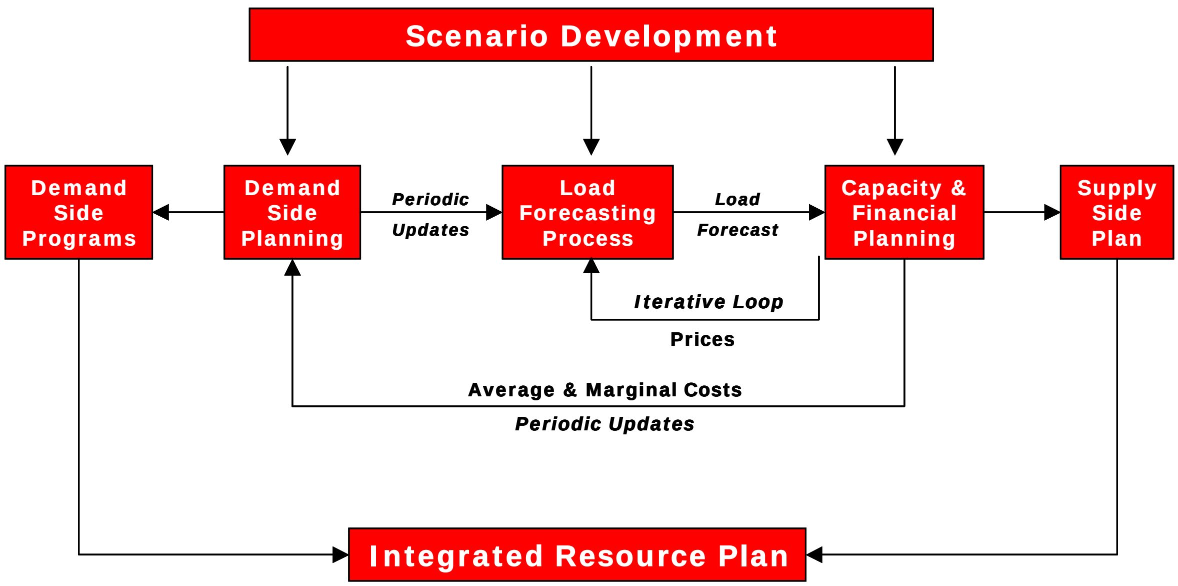
IRP is the process through which decisions are made regarding the resources and programs required to meet a utility's objectives in the areas of electricity supply and demand. IRP is dynamic. It recognizes changes in the utility industry and the specific internal and external environments in which utilities operate. IRP is iterative. It builds on previous resource plans and adapts to new expectations of future circumstances. A flexible and diverse resource plan is better able to satisfy customer needs and will better enable the utility to succeed in the increasingly competitive and uncertain energy markets.

A good, practical integrated resource planning process will evaluate supply-side and demand-side options in a manner consistent with company, regulatory, and customer objectives. The process should reflect the impacts of DSM on load and energy forecasts. A wide variety of supply-side options should also be evaluated when selecting resources to satisfy future requirements. The IRP process should give explicit consideration to price elasticity effects. The process should provide for price feedback loops to closely link the DSM planning process, the generation and transmission capacity planning process, and the financial planning process.

An IRP process should handle significant sources of uncertainty through explicit probabilistic modeling or scenario analysis. The scenario analysis approach is the industry standard for practically dealing with uncertainty.

Practical Integrated Resource Planning Schematic

This practical process integrates supply-side and demand-side options while balancing utility, regulatory, and consumer objectives.



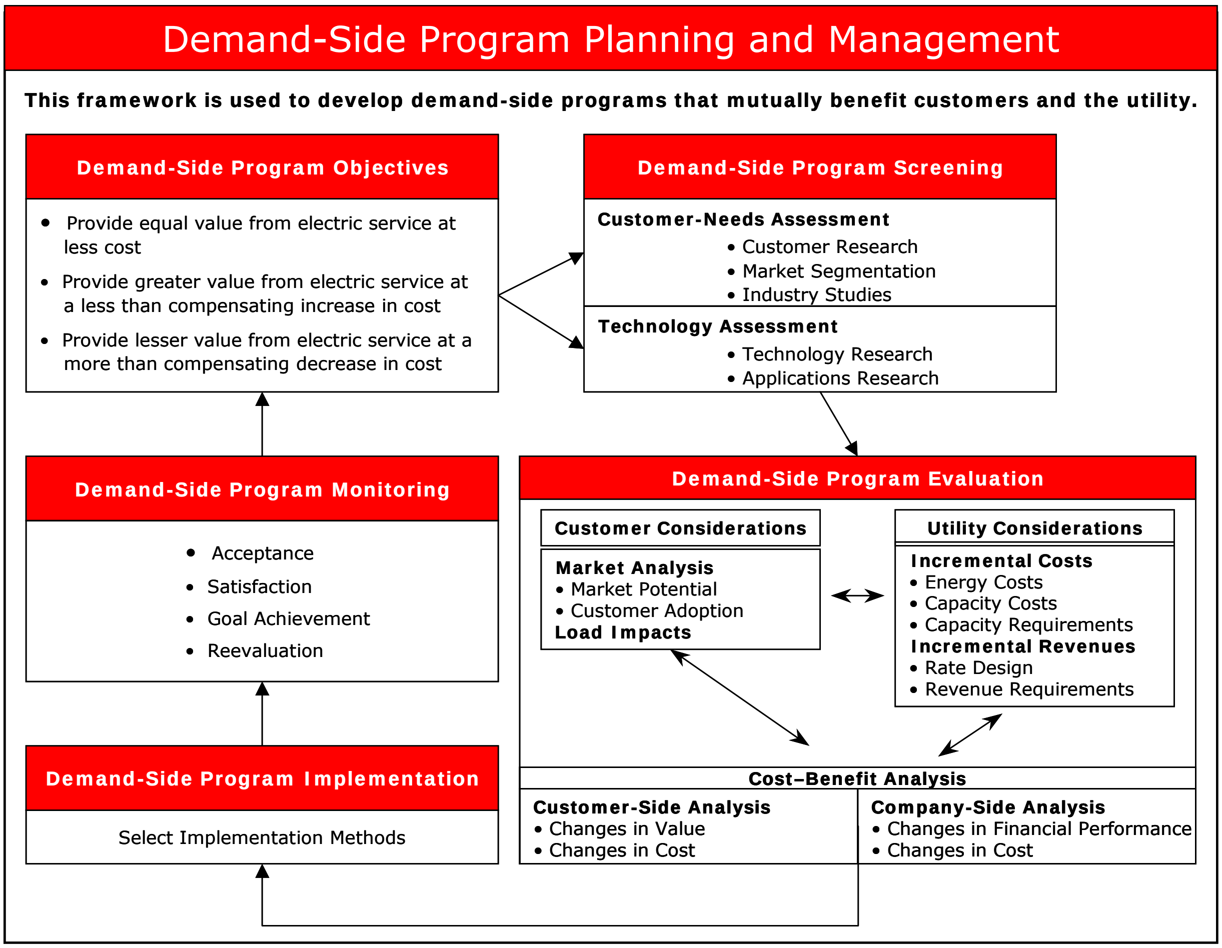
Demand-Side Program Planning and Management

Demand-side planning and management incorporates all utility activities that are designed to influence customer use of electricity in ways that are mutually beneficial to the customer and the utility. By actively influencing the demand for electricity, the utility can help assure efficient use of the electric system and provide a broader range of choices for customers. Demand-side programs are those products, services, tariffs, regulations, policies, or any combinations of these that will influence the time, pattern, and magnitude of participating customers' electrical loads.

The demand-side planning and management process is dynamic. It is flexible, comprehensive, and must accommodate changing conditions.

Process of Demand-Side Planning and Management

The process of demand-side planning and management includes establishing demand management objectives, screening various options, evaluating the options for those with the most potential, implementing the chosen DSM programs, and monitoring their impacts.



Demand-Side Program Objectives

Different combinations of value and cost changes offer the potential for mutually benefiting the utility and its customers. Three such combinations are:

- An equally valued flow of electricity services at less cost

  Example: All customers benefit through lower average prices as a result of a program to encourage the use of high-efficiency heat pumps.

- A lower valued flow of electricity services at a more-than-compensating reduction in cost

Example: Interruptible rates — When customers choose an interruptible services option, they lose some measure of control over their consumption of electricity in exchange for a lower average price.

- A higher valued flow of electricity services at a less-than-compensating increase in cost

  Example: Enhanced power quality (EPQ) — When customers' needs require more electric service reliability than is normally supplied, they can purchase supporting systems and technology that improves reliability.

Demand-Side Program Screening

Demand-side program screening is used to develop candidate demand-side programs that meet the utility's objectives. These candidates spring from the interaction of many independent activities aimed at increasing the understanding of customer needs and capabilities and at improving the services provided by the utility. These activities tend to fall into the categories of customer-needs assessments or technology assessments.

Customer-Needs Assessments

Customers' needs are assessed through customer research, market segmentation, and industry studies.

Customer research, critical to determining customer needs as well as estimating program results, involves soliciting customer opinions through surveys, discussions, and other forms of contact. This research also includes explicitly measuring customer acceptance and response to test DSM programs.

Market segmentation involves grouping customers having similar characteristics. Internal marketing expertise and market research is often needed to identify the characteristics of DSM program adopters. These characteristics will help reveal the market for various DSM programs.

Industry studies help to identify the opportunities and difficulties a utility may face when providing electric service to particular industries. Prospects for new electro technologies, competition from other energy providers, reliability needs within the industry, and prospects for the industry's output should be evaluated. These studies should be periodically revisited and revised so that DSM program offerings to the various industries can be modified to match their needs.

Technology Assessments

Technology assessments are those activities designed to increase a utility's understanding of:

- Customers' methods of production and present use of electricity
- Alternative production methods that may enable customers to save money
- The potential for further electrification of the customers' production processes

Technology assessments will help identify candidate DSM programs by assessing which technologies in what applications will enhance customer value. These assessments can be either research or applications oriented.

Demand-Side Program Evaluation

DSM programs having the potential to benefit both the utility and its customers should be evaluated. The programs must be beneficial from the perspectives of those participating in the DSM program, those that are not, and the utility.

DSM programs should be evaluated using cost-benefit analysis. Before cost-benefit analysis can be applied, the size and extent of the market for the DSM program must be estimated, as well as the program participation and dropout ("churn") rates. The DSM program's effect on participant load shapes also must be estimated, and an understanding of how customer value may change with the program should be explicitly addressed.

Demand-side programs are evaluated using a utility's existing and official estimates of current and future costs. A utility's existing capacity expansion plan provides a set of consistent assumptions, marginal cost estimates, and price forecasts. These should be used as a benchmark for the evaluation of new and continuing demand-side programs.

The interests of the utility and non-participating customers are captured by an evaluation criteria relating to average price. Consequently, the analysis from these perspectives focuses on the changes to average price that will result from implementing demand-side programs. Actions that lower average price will benefit both the utility (per unit costs are lower) and those customers not participating in the demand-side program being evaluated. Since the value of electric service to nonparticipating customers will not change, a reduction in average price will make them better off. Therefore, those demand-side programs that reduce the average price (average revenue requirements) paid by customers pass this non-participants (ratepayer impact measure or RIM) test.

The interests of those customers participating in the demand-side programs are captured by an evaluation criterion relating to customer value. The customer-value criterion compares the net benefits participants will receive by participating in the demand-side program to those they would receive if there were no programs. If the demand-side program generates greater net benefits, the program will pass the customer-value or participant test.

Common Cost-Effectiveness Tests

	RIM	Participant	Total Resource
Benefits	•Revenue Gain •Avoided Supply Costs	•Bill Reduction •Incentives •Avoided Appliance Costs	•Avoided Appliance Costs •Avoided Supply Costs
Costs	•Increased Supply Costs •Utility Program Costs •Utility Paid Incentives •Revenue Loss	•Equipment Costs •O&M Costs	•Increased Supply Costs •Utility Program Costs •Participant Costs

Customer-value benefits can sometimes be difficult to measure; hence, cost-benefit analysis often qualitatively estimates the direction of change in these benefits. Examples of changes in benefits associated with demand-side programs include the level of comfort provided by air-conditioning, lost production due to interruptible rates, the value of enhanced reliability from electric service, or the value of having a cleaner environment or a more self-sufficient energy industry.

Demand-Side Program Implementation

Demand-side program implementation is action oriented. It requires a utility to take actions to intervene in the marketplace. The purpose of these implementation actions is to help realize the DSM program objectives.

A central element of DSM program implementation is the acquisition of participants. There are many methods and "channels" for gaining this participation. Some examples are bill inserts, direct customer contact, web-based enrollment, and advertising via television, newspapers, radio, and brochures.

Incentive payments and rebates are often offered to participants. Coalitions are formed with end-use technology dealers and manufacturers. Special rate designs may be made available to program participants to induce desired changes in customer behavior, equipment choices, and load profiles.

These methods can be used in any combination. Arriving at the most cost-effective mix of implementation techniques is a difficult problem for analysis. Generally, customer and market feedback should be used to alter the mix until management is satisfied with the level and resilience of program participation.

Acquiring DSM program participation is a crucial first step in program implementation. The core of program implementation is the provision of DSM program services. This can be a costly ongoing utility responsibility. Estimates of these costs were necessary in the evaluation stage. The implementation phase requires accurate accounting for them as well as participant acquisition costs.

Demand-Side Program Monitoring

Demand-side program monitoring consists of all those activities that track the program's results and costs. The goal of monitoring is to measure the successes and shortcomings of each program — thus enabling the identification of needed programmatic changes.

Monitoring relies on customer surveys, focus group discussions, and load and market research to help determine the participating customer's level of program satisfaction and identify any program design changes that could improve customer acceptance.

Technologies that may be associated with some demand-side programs are initially evaluated with life-cycle cost methods during the program evaluation stage. Therefore, the utility predicted the effects of the program based on a certain set of assumptions. Comparing the predicted consequences to the actual (monitored) effects allows programs to be reevaluated and modified as necessary.

Differences between the predicted and actual programmatic results can occur because of any number of variances from what was initially supposed. Customer participation ("take-rates" and "churn") is subject to great uncertainty. Often, only scant empirical evidence is available to estimate and project program participation. Therefore, comparing expected with achieved customer participation and response is an important component of the monitoring stage. Detailed program monitoring not only keeps currently implemented programs on track, but also aids in future program evaluation efforts.

Practical IRP — The Iteration Process

As was earlier diagrammed on the schematic of the process, practical IRP should iterate through the three modeling processes common to all utilities:

- Load and Energy Forecasting
- Supply-Side and Capacity Planning
- Utility Financial Forecasting and Planning

A simple way to accomplish these linkages is as follows.

The iteration process between the load and energy forecast and capacity planning links the utility's price forecast to the sales forecast. The iteration may involve several rounds of estimation for the various planning models until acceptable convergence is achieved.

The iteration process begins with an update of the previous electricity price projections used in the load and energy forecasting models. A first round forecast of load and energy requirements is produced and fed to the generation planning and utility financial models. A supply-side plan, with its associated revenue requirements, is produced that generates a second round of electricity price projections. The process is repeated until the supply-side plan and its associated electricity prices do not materially change from those of the previous iteration.

Iterating in this fashion ensures that the electricity price forecast used to determine future load and energy requirements is the same as that embodied in the supply-side plan, revenue requirement projections, and expectations of the utility's financial performance.

Practical IRP — The Scenario Process

Alternative futures for the business, economic, and demographic circumstances that will face the utility are uncertain, probabilistic events. A convenient, tractable way of consistently managing the uncertainty across all three utility planning models is with scenario planning.

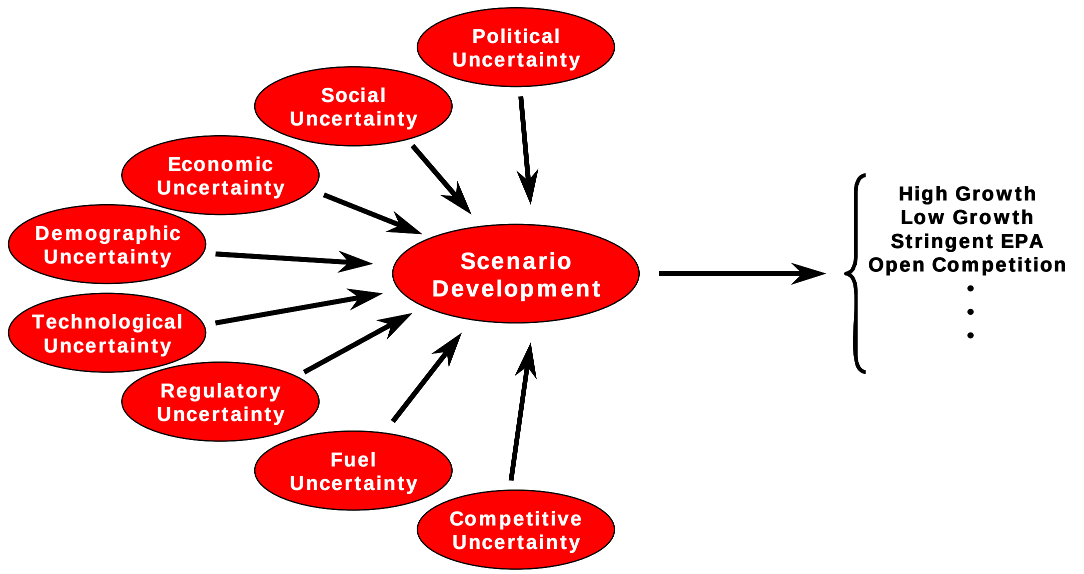
Scenarios incorporate internally consistent quantitative and qualitative assumptions. These assumptions typically cover key economic, political, environmental, and technological factors that will affect the utility's business outlook.

Scenario analysis has the advantage of providing more information to management, policy makers, and regulators than does a single baseline forecast. It allows both higher and lower growth paths, as well as other possible future environments to be evaluated in a consistent manner. Developing different portfolios of demand-side programs and supply-side alternatives across multiple scenarios makes for good planning. Those demand-side programs and supply-side options that appear viable across many scenarios are less risky than those that do not.

Scenarios should be developed comprehensively. A broad array of influencing factors should be generated with the help of topic experts. People representing divergent interests, from both inside and outside the utility, should be asked to participate on panels that will cover the economic, social, environmental, political, and technological areas that will influence the utility's load and energy growth. This scenario development approach assures that internally consistent scenarios are developed. Such consistency is not assured using less formal methods.

Scenario Development

Scenarios describe alternative future business environments by developing internally consistent assessments of key uncertainties.



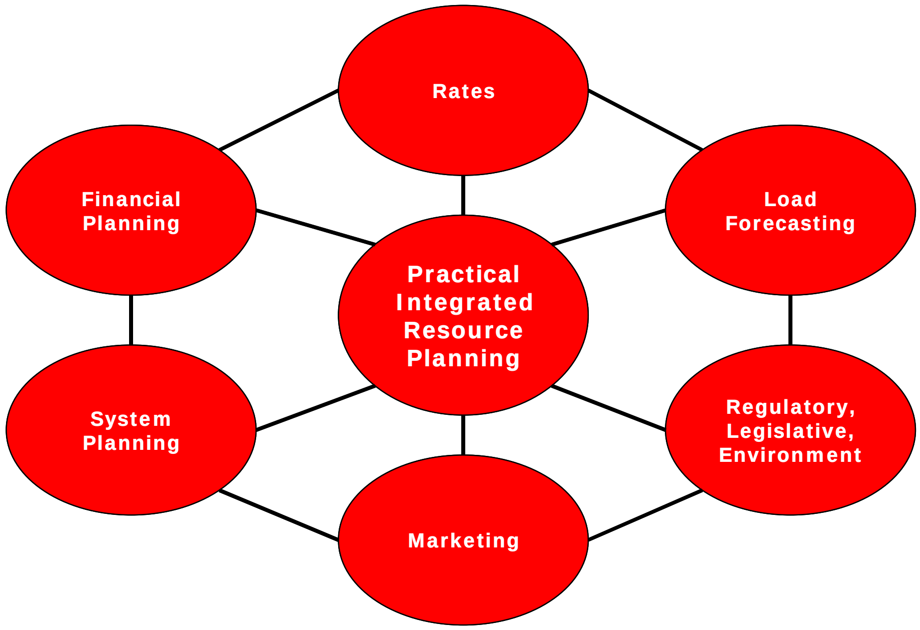
Practical IRP — The Result

After receiving management approval, the IRP and its expected financial consequences are reflected in the supply-side plan (also known as the capacity expansion plan), the utility's official load and energy forecast, and in the approved set of new and ongoing demand-side programs. These and other reports, plans, documents, and outputs contain much of the information needed for the evaluation and reevaluation of supply- and demand-side options and programs when the IRP needs to be updated.

The IRP that results from the process described in this document is dependent upon the explicit involvement of diverse functional areas within the utility.

Integration of Diverse Utility Functional Areas

The IRP process relies on and improves internal utility coordination.



The resulting plan represents an integration of more than just supply- and demand-side options. It represents an integration of people, organizations, and management. The plan will represent the utility's best efforts to anticipate its customers' future electricity requirements and to provide for those requirements in an effective and efficient manner.